

## Digital Camera Selection

Selecting a compatible digital microscope camera for use on a microscope is not difficult but does require some careful considerations. Camera performance is a function of many items; the microscope optics design, the camera optical coupler, the type of sensor, pixel size, and sensor size.

We offer a wide range of high quality camera models and resolutions on our website. If you would like our assistance on camera selection and needed installation items for your microscope please contact us at [oem-optical.com](http://oem-optical.com).

### Camera Resolution needed?

The first decision will be how many megapixels do I need? Usually people relate their need for pixel count to the on-going consumer camera battle; that more is better. With microscopy the need for pixel count is only one factor. Generally the resolution needed *increases* with lower and macro magnifications. Sensor quality, pixel size, sensor type, and final use are all factors to consider. Worth noting is that our most popular cameras sales are the 1.5MP and 2MP CCD models for scientific applications where the users find image resolution is more than adequate for documents and it's easier to deal with the file size.

As a comparison example; with a consumer camera, a photograph may take in a large scene due to limited optical zoom range and later the needed portion is cropped out resulting in 'wasted' pixel information but requiring more sensor pixels initially to achieve detail in the cropped portion. When using a microscope the image is properly framed for the most significant details choosing the appropriate magnification with the objective lenses; you capture only what you want, essentially cropping with the optics.

### Type of microscopy ?

The method of microscopy to be primarily used has a great impact on the type of camera and sensor that is suitable.

- Brightfield: Brightfield illumination generally provides high light intensity. Either a CMOS or CCD sensor camera would work fine in this application.
- Darkfield: Most darkfield illumination is sufficiently bright enough for CMOS sensor cameras although at high magnifications the exposure times may become long and vibration can become an issue.
- DIC/Nomarski: The available light tends to be on the low side particularly at high magnifications. CCD sensors would be the best choice.
- Phase Contrast/Hoffman modulation:
- Fluorescence: Fluorescence image capture requires good low light sensitivity in most cases. For strong fluorescence signals a standard CCD camera would work well and we would not recommend a CMOS sensor model.
- Fluorescence – trace: For trace level fluorescence it is critical that a low noise, highly sensitive camera be selected. Peltier cooled models are the best choice. For maximum spatial detail a monochrome model would be even better since there isn't a Bayer mosaic filter layer blocking light to the sensor. If higher resolution with cooling is planned than an optical shift model performs best (such as the Pixera 600CL series).
- Image analysis: In applications where image analysis, such as cell growth, is anticipated select a camera that uses a **0 defect sensor** (usually CCD scientific models) to ensure only 'real' image data, not stuck pixels, are being analyzed.

## What will the images be used for ?

The ultimate use of the captured image is the critical piece of information. If you have too high a resolution camera for your application the file sizes may become a problem to deal with. As an example – If the intended use of the camera is to document defects in a specimen and the images are going to be put into a WORD document (or attached at 800 x 600 resolution  $\approx$  0.5 megapixel), there is really no need for a 5 MP camera. In this case a 1.5 - 2MP model would provide adequate resolution without creating huge file sizes that would require resizing. On the other hand, if your primary use is image analysis than all the resolution possible (limited by objective lense resolution) would be useful. In this instance the 3-5 MP camera would be a better choice. If macro imaging is the application than one of the pixel shifting very high resolution cameras would be of benefit. Another option is a full frame sensor (35mm format) which would be the best for macro but will require the K or F-mount lenses. These full frame sensors typically have larger photo-sites with better light gathering capability, more dynamic range, and low thermal noise but at a higher camera and interface cost.

## Sensors:

Both CCD and CMOS sensors can be used in microscopy applications but where lighting is low and imaging is critical a CCD sensor is the better choice. Pixel size is also important as it directly relates to the sensors light gathering ability. Larger pixels (photo sites) gather more light providing increased sensitivity and reduced image noise. If your application requires good low light performance choose a CCD sensor with larger pixels. Sensors come in various grades. Choose a camera with screened 0 defect sensors for critical imaging applications. These may also be individually characterized on some models (Pixera models) offering better linearity, sensitivity, and color saturation.(Pixera). See our [scientific vs consumer](#) camera tutorial for additional information on the differences in sensors.

## Pixel Shifting models:

Most microscopy photographs are taken of static objects and scientific camera manufacturers use this fact to greatly enhance available resolution by a process known as pixel shifting. This has the advantage of providing the very high resolution needed for lower power macro lenses while using a smaller sensor size that requires less costly optical couplers (standard c-mount rather than F or K mount). The camera performance benefits from larger pixels since lower resolution sensors are used that offer the larger photo sites relative to sensor size (eg – 1.5MP on a 1/2" sensor vs 5MP on a 1/2" sensor) The pixel shifting is usually done using two methods. Some move the sensor while others move an optical element to achieve the increased resolution. The final result is the same but there are considerations with both methods particularly when using sensor cooling. Shifting models are available with either CMOS or CCD sensors. The CCD sensors are a better choice for lower light level applications than CMOS sensors in most cases.

## 'Cooled' Pixel Shifting models:

In applications with very low available light, such as trace fluorescence, many pixel shift models display a grid pattern when used with low light levels due to insufficient light sensitivity. A proper selected Peltier cooled model will reduce this occurrence. If a Peltier cooled model is contemplated, the best choice of a pixel shift design would be one that uses an optical element for the shift. The primary reason is that with the optical shift method the CCD sensor, since it is stationary, can have maximum thermal contact with the Peltier device for the maximum cooling benefit of reduced thermal noise and better sensitivity. With a mechanical shift method the CCD sensor must move (in a 3x3 or 4x4 array of positions) so the sensor mass must be minimized for proper shifting which reduces thermal conductivity and the resultant reduced performance.

## Final thoughts:

This paper summarizes our suggestions for camera selection based on the sales and successful installation of thousands over the past 10 years. It is not the 'be-all, end-all' for microscope camera selection as each user application is unique in its requirements. See our [camera selection cross reference](#) chart for more information on our cameras and their suggested application.